ROAD DESIGN PROPOSAL FOR THE PAVEMENT AND DRAINAGE SYSTEM OF THE ROAD EXTENSION FROM WARAYAN TO SOLDIERS HILLS III, MIRAMONTE PARK EAST

A Quantitative Research

Presented to the Faculty of Civil Engineering Division

La Concepcion College

In Partial Fulfillment of the Requirements for the Degree

Bachelor of Science in Civil Engineering

Major in Construction Engineering

and Management

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August 2025

RECOMMENDATION

This is to certify that this research, titled "ROAD DESIGN PROPOSAL FOR THE PAVEMENT AND DRAINAGE SYSTEM OF THE ROAD EXTENSION FROM WARAYAN TO SOLDIER HILLS III, MIRAMONTE PARK EAST", prepared and submitted by Kirbie Lu Dira, Jessie G. Libo-on, Geremie K. Tatlonghari and James Bryan S. Virola in partial fulfillment of the requirements for the degree Bachelor of Science in Civil Engineering major in Construction Engineering and Management , is hereby recommended for Pre-Oral Defense.

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CERTIFICATE OF ORIGINALITY

We hereby certify that this thesis is our own work and that to the best of our knowledge and belief, it contains no material previously written or published by another person or organization nor any material which has been accepted for award of any other degree or diploma from a university or institution of higher learning, except where due acknowledgement is made thereof.

Furthermore, we declare that the intellectual content of this thesis is the product of our work although we have received assistance from others on the manner of organization, presentation, language, and style.

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CHAPTER 1

The Problem and Its Background

Introduction

Roads are very important infrastructures that connect people, goods, and services in a community. A well-designed and properly maintained road network supports development in the area and improves accessibility. According to the Department of Public Works and Highways (DPWH, 2015), proper design of roads plays an important role in promoting safety, comfort, and efficient transportation. Poorly constructed or poorly maintained roads are prone to accidents, damage or destruction of vehicles, and slow movement.

One reason why roads are in poor condition is the absence of a proper drainage system. The United Nations Office for Disaster Risk Reduction (UNDRR, 2017) notices that poor drainage leads to flooding, which increases the rate of deterioration of pavement and lowers the safety of the community. For this reason, it is important to integrate proper pavement and drainage design to ensure the road's long-term performance, durability and sustainability.

This study focuses on designing an improved pavement and drainage system for the proposed road extension connecting Warayan and Soldiers Hills III in Miramonte Park East. The design will be based on survey data and it will follow the

DPWH standards to address the existing problems of damaged roads and flooding during moderate to heavy rainfall.

Background of the study

Miramonte Park East community experiences frequent flooding and deterioration of the roads, especially in the area between Warayan and Soldiers Hills III. The current road is broken, cracked, and lacks an effective drainage system. Currently, the Miramonte relies on open canals that overflow during rainfall, causing water to stay on the road surface and making it difficult for vehicles and people to pass. These conditions negatively affect daily transportation, safety, and the overall living condition in the community.

Based on the visual observations of the residents and initial site assessment, even moderate rain causes flooding due to poor drainage and uneven road elevation. The DPWH Manual on Road Drainage Design (2015) says that the drainage must be properly designed to prevent ponding and ensure that the flow of water continues. Without such a system, road pavements can quickly weaken and deteriorate due to long exposure to water..

To address these problems, this study aims to create a road design proposal that includes both a pavement structure and a drainage layout that is best suited to the conditions of Miramonte Park East. The design will consider local rainfall intensity, soil characteristics, and road geometry. The main goal is to improve the road's durability, reduce flooding, and provide a reference design of road and drainage for

local government use in future development projects.

This research is also aligned to the goal of the national government to improve local infrastructure and promote climate-resilient road networks (DPWH, 2020). By focusing only on design and planning, this study contributes to sustainable community development and supports better, and safer transportation systems

Theoretical Framework

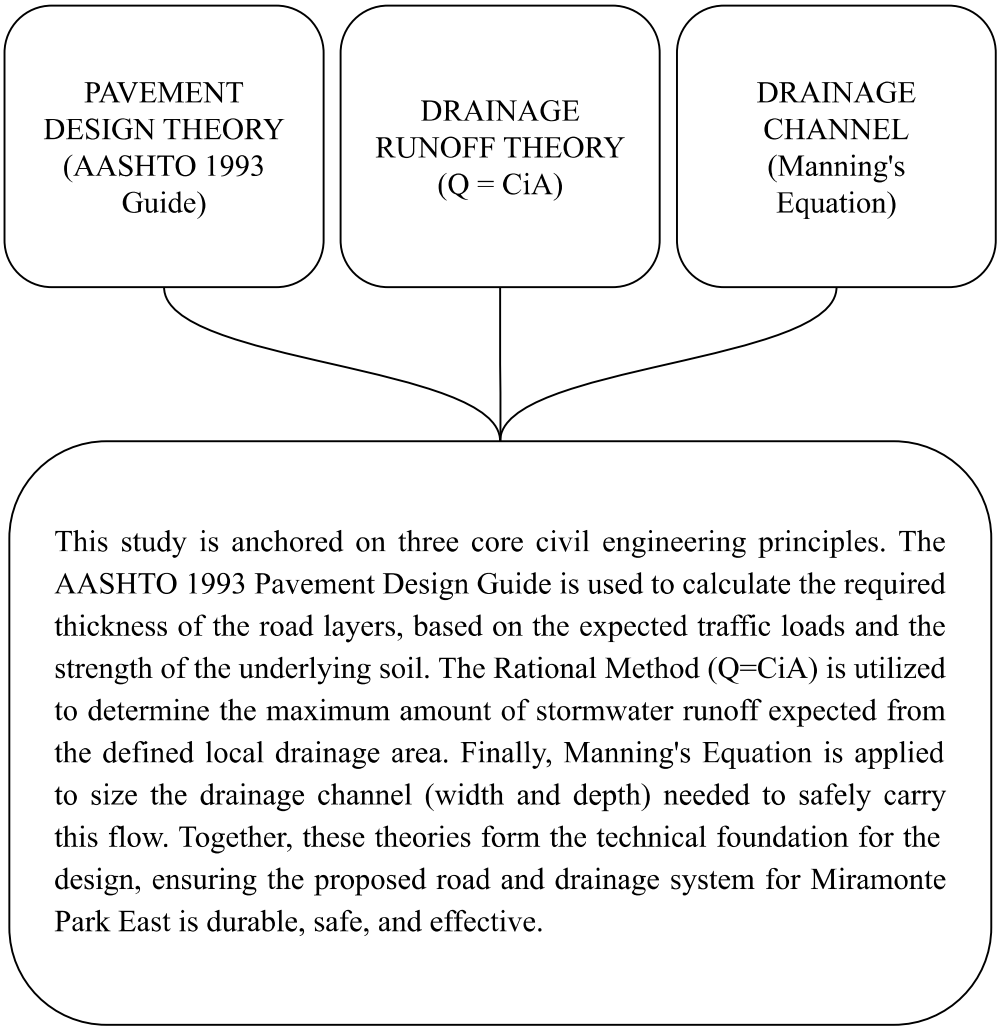
PAVEMENT DESIGN THEORY (AASHTO 1993 Guide)
DRAINAGE RUNOFF THEORY (Q = CiA)
DRAINAGE CHANNEL (Manning's Equation)
This study is anchored on three core civil engineering principles. The AASHTO 1993 Pavement Design Guide is used to calculate the required thickness of the road layers, based on the expected traffic loads and the strength of the underlying soil. The Rational Method (Q=CiA) is utilized to determine the maximum amount of stormwater runoff expected from the defined local drainage area. Finally, Manning's Equation is applied to size the drainage channel (width and depth) needed to safely carry this flow. Together, these theories form the technical foundation for the design, ensuring the proposed road and drainage system for Miramonte Park East is durable, safe, and effective.

Figure 1. *Theoretical Framework*

Conceptual Framework

INPUT	PROCESS	OUTPUT
1. What is the current condition of the existing roadway and drainage system in Warayan terms of: 1.1 Pavement condition 1.2 Drainage layout 2. How will the analysis of soil properties, rainfall data, and traffic loads influence the design of the pavement extension and drainage system in terms of: 2.1 Pavement thickness 2.2 Drainage system capacity 3. What are the benefits of the proposed pavement extension and drainage system for residents, commuters and drivers in terms of: 3.1 Sustainability 3.2 Accessibility 3.3 Road safety 4. How feasible is the proposed design of pavement extension and drainage system in terms of: 4.1 Constructability 4.2 Project cost	1. Survey questionnaire 2. Face to face interview 3. Data gathering 4. Data analysis 5. Design phase and simulation 6. Cost estimation	1. A Comprehensive Road Design Proposal for the pavement and drainage system of the road extension from Warayan to Soldiers Hills III. 2. This proposal will include the following key components: ● An assessment report on the current condition of the existing pavement and drainage system. ● Detailed engineering design plans and specifications for pavement structure and drainage system ● A feasibility analysis containing a constructability assessment and a detailed project cost estimate ● An evaluation report on the expected benefits of the proposed design in terms of improved sustainability, accessibility, and road safety.

Figure 2. *Conceptual Framework*

Statement of the Problem

This study aims to identify the existing problems in the current road condition and drainage system between Warayan and Soldiers Hills III in Miramonte Park East, and to design a proposed pavement and drainage system. Specifically, this study seeks to answer the following questions:

1. What is the current condition of the existing roadway and drainage system between Warayan and Soldiers Hills III in terms of:
   1.1 Pavement condition
   1.2 Drainage layout
2. How will the analysis of soil properties, rainfall data, and traffic loads determine the design specification for the pavement extension and drainage system in terms of:
   2.1 Pavement thickness
   2.2 Drainage system capacity
3. What are the benefits of the proposed pavement extension and drainage system for residents, commuters and drivers in terms of:
   3.1 Sustainability
   3.2 Accessibility
   3.3 Road safety
4. How feasible is the proposed design of pavement extension and drainage system in terms of:

4.1 Constructability

4.2 Project cost

Objectives of the Study

This study aims to propose an improved pavement and drainage system design for the road extension connecting Warayan and Soldiers Hills III in Miramonte Park East, addressing the issues of damaged pavement and flooding due to the absence of an effective drainage system. Specifically, this study aims to:

1. Evaluate the current condition of the existing roadway and drainage system in terms of:
   1.1. Pavement condition
   1.2. Drainage layout
2. Analyze how soil properties, rainfall data, and traffic loads influence the design of the pavement extension and drainage system in terms of:
   2.1. Pavement thickness
   2.2. Drainage system capacity
3. Determine the benefits of the proposed pavement extension and drainage system for residents, commuters, and drivers in terms of:
   3.1. Sustainability
   3.2. Accessibility
   3.3. Road safety

4. Assess the feasibility of the proposed design in terms of:
    4.1. Constructability
    4.2. Project cost

Hypothesis

Null Hypothesis (Ho): The proposed pavement and drainage design for the road extension from Warayan to Soldiers Hills III in Miramonte Park East does not significantly improve road strength, safety, flood control, and cost efficiency compared to the existing condition.

Alternative Hypothesis (Ha): The proposed pavement and drainage design for the road extension from Warayan to Soldiers Hills III in Miramonte Park East significantly improves road strength, safety, flood control, and cost efficiency compared to the existing condition.

Significance of the Study

The result of the study, “Road Design Proposal for the Pavement and Drainage System of the Road Extension from Warayan to Soldier Hills III, Miramonte Park East”, will be beneficial to the following:

Residents and Commuters - The residents of Miramonte Park East will benefit from reduced flooding and improved road conditions. A well-designed pavement and drainage system will enhance safety, improve transportation, and will lessen property

damage as a result of ponding of water and erosion.

The Local Government Unit (LGU) - The proposed design can be used as a reference by the LGU of Miramonte Park East or the City of Caloocan in planning and constructing future road and drainage projects. It can help as a guide for decision-making for infrastructure development and flood control programs in nearby areas.

The Academic Institution - The study will contribute to the institution's collection of engineering research outputs, and will serve as a practical example of how civil engineering principles can be applied to come up with community-based solutions.

Civil Engineering Students and Researchers - This research may serve as a reference for students who want to conduct similar studies in road and drainage system design. It can also give an insight on how to apply engineering standards and design principles to real community problems.

Department of Public Works and Highways (DPWH) - The proposed design can support the agency's mission of ensuring that the road network is sustainable and well-engineered, especially in community-level infrastructure.

Scope and Limitation of the Study

This study focuses only on creating a road design proposal for the pavement and drainage system of the road extension connecting Warayan and Soldiers Hills III in Miramonte Park East. It involves the assessment of the current state of the road and drainage system, as well as engineering data analysis of soil characteristics,

traffic volume, and rainfall intensity in the area.

The design uses fundamental civil engineering principles and is designed according to recognized design standards like AASHTO 1993 Pavement Design Guide for calculation of pavement layer thickness, and the Rational Method and Manning's Equation to estimate the size and design of the drainage system. The final output of this research study is a realistic design plan which contains a proposed layout, estimated cost of the project, schedule, and expected lifespan of the road and drainage system.

However, this research is limited only to the design phase. It does not include the actual construction, implementation, bidding as well as the monitoring of post-construction of the proposed project. The study also relies on the availability and reliability of data gathered through surveys or secondary sources, which may be limited by the time and resources that are available to the researchers. The cost estimates are based on assumed market prices at the time of the study and may change once an actual project is executed. Lastly, the study is limited to the design of pavement and drainage system only, without including other road components like sidewalks, streetlights, or relocation of utilities.

Definition of Terms

Pavement - Pavement refers to a hard surface layer constructed on a road to support traffic loads and distribute them to the underlying soil (Yoder & Witczak, 1975). In this study, it is the proposed concrete road surface designed

withstand the expected traffic load in Miramonte Park East.

Drainage System - A drainage system is a system of channels, pipes, and structures that collect and remove excess surface water on roads or grounds to avoid flooding (Department of Public Works and Highways [DPWH], 2015). In this study, it refers to the designed system that will manage rainwater runoff along the proposed road extension.

Road Extension - Road extension refers to the continuation or expansion of an existing roadway to improve access and connectivity between communities (AASHTO, 1993). In this study, it pertains to the proposed additional road that connects Warayan and Soldiers Hills III.

Flooding - Flooding is a general build up or overflow of water on land that is normally dry due to heavy rainfall or poor drainage (United Nations Office for Disaster Risk Reduction [UNDRR], 2017). In this study, it refers to the overflow of water along the road due to the lack of a proper drainage system.

Soil Characteristics - Soil characteristics refers to the physical and engineering properties of soil, such as texture, density, and bearing capacity, that affect construction design (Das, 2010). In this study, it refers to the properties of soil analyzed to determine the pavement layer thickness and stability.

Traffic Load - Traffic load is a term that is used to describe the weight and frequency of vehicles using a roadway that influence its design and service life (AASHTO, 1993). In this study, it refers to the estimated number and

weight of vehicles considered in the pavement design.

Rational Method - The Rational Method is a formula that is used to estimate the peak discharge or runoff of a drainage area during rainfall and the equation is written as Q=CiA (Kuichling, 1889). In this study, it is used to compute the stormwater flow needed for drainage design

Manning's Equation - Manning's Equation is a mathematical equation used to calculate the flow of water in open channels in terms of the slope, hydraulic radius, and surface roughness (Chow, 1959). In this study, it is applied to determine the size and slope of drainage canals.

AASHTO 1993 Pavement Design Guide - The AASHTO Pavement Design Guide provides methods and formulas for determining pavement thickness based on soil strength, traffic, and environmental condition (American Association of State Highway and Transportation Officials [AASHTO], 1993). In this study, it is used as the basis for the pavement design calculations.

Design Layout - Design layout is a graphical representation of an engineering plan that shows the arrangement, alignment, and components of a project (DPWH, 2015). In this study, it refers to the prepared engineering drawings of the proposed pavement and drainage system.

CHAPTER 2

Review of Related Literature and Studies

Foreign Literature

Pavement design worldwide continues to rely heavily on the AASHTO 1993 Pavement Design Guide, which remains a cornerstone in modern road engineering despite the emergence of newer mechanistic–empirical approaches. Li and Chen (2020) emphasized that this guide provides a structured method for computing pavement layer thicknesses based on soil bearing capacity, traffic loading, and subgrade conditions. They further noted that while technological advancements have introduced simulation tools, the AASHTO 1993 method's simplicity and reliability make it indispensable in developing countries.

Building upon this, Rahman and Lee (2021) discussed the crucial role of drainage systems in maintaining pavement longevity. They highlighted that poor water management is one of the leading causes of road failures, as moisture weakens the pavement subgrade, leading to rutting and cracking. Their study also reaffirmed the value of using hydrologic tools such as the Rational Method and Manning's Equation, which are essential for calculating runoff and designing canal capacities that protect the pavement structure during heavy rainfall.

As pavement deterioration is often influenced by soil–water interaction, Zhang and Liu (2021) explored how digital modeling and simulation tools help engineers predict the effects of rainfall and traffic loading before construction. Their

research demonstrated that pre-design simulations reduce construction errors and ensure that pavement layers are optimized according to both traffic demand and drainage performance. This proactive approach minimizes maintenance costs and extends the service life of the road network.

Similarly, Patel and Reddy (2022) examined the interaction between traffic loads and flexible pavement response under varying moisture conditions. They found that roads with insufficient drainage experience faster deterioration even if the structural design is adequate. The researchers suggested that integrating soil stabilization techniques with proper drainage design results in better pavement strength and longer performance life, especially in tropical regions.

Complementing these findings, Wang et al. (2023) demonstrated how digital hydrologic modeling improves the precision of pavement and drainage design. Their study incorporated rainfall intensity data into computer-based design models, allowing for accurate prediction of peak flow and potential flooding points. They concluded that such integration enhances safety, reduces road closure incidents, and promotes sustainable infrastructure planning.

Local Literature

The Department of Public Works and Highways in the Philippines (DPWH) gives the main structure for local drainage and road planning through the design guidelines, standards, and criteria (DGCS). The DPWH (2020) stated that because these recommendations are based on the AASHTO 1993 design principles, they have

been modified to account for local soil conditions, temperature, and building materials. The DGCS provides the detailed pavement design process, assuring that local Engineers provide consistent, dependable, and economical road systems across the nation.

In regards to this, DPWH (2021) developed revised standard specifications for airports, bridges, and highways that define the quality and standards of materials in control methods. These guidelines ensure that local highways are planned with the proper drainage, thickness, and compaction factors for sustaining both weather and traffic. These specific details are helpful.

Additionally, Drainage and Slope Protection was published by DPWH in 2022 rules for building storm drains, drains, and canals. Manning's equation for channel capacity is used in standard computation and needs the use of data from flood return periods to make sure that the systems can manage the expected amounts of rainfall. This is especially important for groups such as Miramonte Park East, where frequent flooding occurs during periods of high rainfall.

At the same time, the Philippine Atmospheric, Geophysical, and Astronomical Services Administration (PAGASA, 2023) offered the most recent Stormwater based on intensity-duration-frequency (IDF) curves design calculations across the country. These lines serve as data for the Statistical Method, helping engineers to compute the drainage and high runoff rates that are realistic sizes. PAGASA’s improved rainfall records ensures that road and drainage plans can change to the climate rainfall.

Lastly, the National Engineering Center (NEC, 2024) created modern engineering manuals that make it easier to apply design guidelines for small-scale road construction projects. These manuals focus on efficient methods, suitable methods for soil testing and material selection, supporting regional engineers, even with minimal cost, to create effective drainage and paving systems. These locals ensure the Philippine road constructing standards that are both environmentally friendly and technically sound.

Foreign Studies

In a Bangladeshi case study, Ahmed and Karim (2020) used AASHTO 1993 recommendations for design to enhance rural road networks that are frequently flooding. According to their results, supporting the lower quality using local pavement, life was greatly increased by using materials and providing side drainage 35% less was used on improvements. The investigation showed how flexible actual design strategies are in poor nations facing comparable climatic challenges to the Philippines.

Johnson et al. (2021) continue discussion about drainage efficiency, examining Australia's Rational Method-designed stormwater management systems. They discovered that mixing real-time rainfall monitoring with environmental modeling improved the accuracy of flood event prediction, allowing safety maintenance and quicker reaction to severe weather.

Singh and Mehta (2022) studied the effectiveness of durability pavements in India. It tells the importance of soil strength of the data for construction design. They reduce it by developing thicker road designs that are more safe under heavy traffic by using data from soil research. This approach highlights the significance of geotechnical testing for roadways. Design, which is directly related to the current study's focus on soil analysis.

In the meantime, Zhang and Li (2023) studied China's sustainable road design, by using effective drainage layers and recycled rocks. Their research says employing permeable foundation materials improved the water flow to extend the life of the road by reducing the caused by moisture. This connection between effective drainage planning and material selection.

Lastly, Kim et al. created a coordinated study in South Korea (2024). Applying structural and hydrologic analysis, the pavement and drainage systems are studied together. They discovered that by maintaining stable foundation conditions, combining the services, reduces the livelihood of restricted flooding in a single framework pavement life.

Local Studies

In the Philippines, a number of recent research have focused on improving road design that takes flooding and pavement damage into consideration. Santos and Reyes (2020) monitored Laguna's barangay road drainage systems, showing that properly constructed canals based on Manning's Equation helped better driving conditions and less surface water. Its study shows the importance of having drainage design early in the development procedure.

In the same direction, Lazaro (2021) created a plan for a barangay road in Cavite using the Rational Method and AASHTO 1993 standards. It shows the drainage design and road construction are completely working, the high rainfall, flooding and road damage are reduced, by improving the sustainability of the project.

Mendoza and Cruz (2022) applied soil testing to find out regional roads layer designs, conducting data and found that providing substandard CBR data improves the reliability of thickness of layers calculations. Due to their research, local soil Road performance is greatly affected by these factors, which should always be taken into consideration, into choices about design.

Fernandez and Dela Cruz (2023) built on this with an evaluation review of Batangas' drainage systems, finding that road segments having There were reduced cracks and structural issues with integrated pavement and drainage systems failures. Their results are in favor of using comprehensive design techniques similar to this investigation.

Villareal (2024) studied the effects of drainage improvements in a related study. In Quezon City, she discovered that highways with strong structures open canals, combining catch basins successfully controlled by stormwater runoff and protected local flooding. These findings show the usefulness of drainage system design that enhances the structural integrity of the pavement.

Synthesis of Literature and Studies

The reviewed literature and studies from 2020 to 2025 reveal a unified understanding that effective road design is achieved through the integration of pavement structure and drainage systems. International literature shows the theoretical framework using hydrologic and AASHTO-based design techniques calculations utilizing Manning's and Rational Equations. Literature from that region shows how the Philippines has adopted these international standards using NEC engineering, PAGASA rainfall data, and DPWH guidelines instructions.

These studies performed both domestically and abroad consistently show soil characteristics, the two most important elements affecting road conditions are loading and rainfall seriousness performance. All of these results support the importance of localized road design methods that take into account geotechnical and environmental conditions. The design for the road extension's pavement and drainage system from Warayan to Miramonte Park East's Soldiers Hills III , effective drainage systems and pavement design is necessary in reducing the risk of flooding and ensuring the community road has safe, durable, and affordable infrastructure.

CHAPTER 3

Research Methodology

Research Design

This investigation will understand a quantitative research design because it seeks to establish the most appropriate pavement and drainage system to be used in the extension of the road between Warayan and Soldiers Hills III and East of the Miramonte Park. This paper is concerned with gathering, measurement and analysis of numbers in engineering factors involved in the design of roads.

The quantitative data will be collected regarding the amount of traffic, the characteristics of the soils, the degree of rainfall and the flow rates and the drainage capacity. Traffic data will be derived by use of actual traffic counts, which will be performed over a given time of observation. Available meteorological records will be used to get rainfall data and for the soil property test, Dynamic Cone Penetration (DCP) will be conducted. The hydraulic and hydro-logic calculations of flow rates and drainage performance will be done based on the collected data.

The data collected would be statistically assessed and evaluated to produce design values and parameters on which the most efficient pavement and drainage system will be chosen. Using this purely quantitative method, the analysis will seek to offer a solution to the study on an engineering basis, which helps to ensure the durability of the structure, safety, and the drainability capacity of the proposed road project.

Sample and Population

The sample respondents of the research were people who reside on the path line of the proposed road extension, the residents, daily commuters of the road as well as the drivers. The criteria that we used was purposive sampling (i.e. the participants were chosen through their capacity to offer valuable information related to the study and their understanding of the road conditions). Ten road users comprising the tricycle and motorbike drivers were used as the sample population as well as people of the area of Warayan and Soldier Hills III comprising fifty individuals. The mix of the participants provided us with both technical and practical perspectives of the project, and it makes the participants understand the real issues the community was dealing with more properly and ensured the proposed design considered engineering elements.

Research Instrument

The main instrument used in this study was a survey questionnaire prepared by the researchers. It was intended to collect data on the state of the roads, the frequency of flooding, user satisfaction, and what people think are needed for improvement. Responses were rated on a five-point Likert scale, which ranged from "Strongly Agree" to "Strongly Disagree." Besides the survey, the researchers employed interview guides to have casual discussions with locals and the study of documents to collect secondary data from internet and public sources, including topographic maps, rainfall records, and soil categorization. The preliminary design concept for the pavement and drainage system was developed using this extra data, which supported the survey results, and for the purpose of creating a design model of the pavement and drainage system, the researchers will use autocad and sketch up as the software tools. The self-made Questionnaire is distributed and validated by three qualified experts who hold relevant academic and professional credentials. These validators included individuals who had served as thesis or research panel members and those who had completed a master’s or doctoral degree.

Data Gathering

The researchers prepared a survey questionnaire that concentrated on the conditions of the roads, frequency of floods, satisfaction, and advice the respondents on how they could improve the situation; the questionnaire was prepared using a five-point Likert scale; Strongly Agree to Strongly Disagree.

Survey: The questionnaire was given to the chosen respondents, which collected primary information based on their judgements and personal experience of the issues.

Secondary Data: The researchers gathered secondary data through internet and publicly available sources which contained topographic maps, rains and soils classification.

Data Integration: After completion, the primary data and secondary data was combined together to serve in helping to inform the initial design concept of the pavement and drainage system.

Software Instrument: The researchers will employ the use of autocad and sketch up for creating a design model of the pavement and drainage system based on the collected data.

Means of Data Collection Survey: Face to face, possibly online, survey On whether there were methods available.

Data Collection Time Frame

The whole process of data collection was about 1 - 5 days which was sufficient to allow adequate time to distribute surveys, make interviews and to do a comprehensive compilation and analysis of the secondary data.

Statistical Tool

The researcher used statistical tools, particularly percentage and mean, for the data that were gathered. The data gathered will be tabulated, organized, and interpreted. The data were treated using the following statistical tools.

1. Percentage - This was used in determining the demographic profile of the respondents.

   Formula: $P = \frac{f}{N} \times 100$

   Where:

   P = Percentage

   f = Frequency of an item or response

   N = Total number of respondents

   100 = Constant multiplies.

2. Weighted Mean - This tool was used to determine the respondents' assessment of the existing road condition and the proposed pavement and drainage design.

   Formula: $WM = \frac{\Sigma(f \times w)}{N}$

Where:

WM = Weighted Mean

W = Weighted of option choices

X = Frequency of each response

N = Number of respondents

3. Likert's Scale - It is a prearranged system, a one-dimensional scale from which the interviewee would choose one option that reflects their opinion.Five (5) options will be offered

Rate	Verbal Interpretation	Range
5	Strongly agree	4.20-5.00
4	Agree	3.40-4.19
3	Neutral	2.60-3.39
2	Disagree	1.80-2.59
1	Strongly disagree	1.00-1.79

To qualify the responses on the rating scale, a five-point Likert scale method of measuring attitudes was used. Each statement has five responses, which were classified under the degree of frequency with the corresponding weight. The weighted mean was computed by multiplying the frequency of each response by its corresponding weight, summing the products, and then dividing the total by the number of respondents. This equivalent point

assigned to each indicates the existence of the condition as perceived by the respondent and was determined by estimating each weighted mean, which becomes the descriptive interpretation.

4. Rational Method - The Rational Method was used to estimate the peak discharge (Q) or the maximum rate of runoff from the drainage area during rainfall. It is expressed by the equation:

   Formula: $Q = C \times i \times A$

   Where:

   Q = peak discharge (m^3/s)

   C = runoff coefficient (dimensionless, depends on surface type)

   i = rainfall intensity (mm/hr or m/s)

   A = drainage area (hectares or m^2)

5. Manning's Equation - The Manning's Equation was used to compute the velocity and flow rate of water in open channels or drainage canals. It is expressed as:

   Formula: $\frac{1}{n} A R^{2/3} S^{1/2}$

   where:

   Q = flow discharge (m^3/s)

   n = Manning's roughness coefficient (depends on channel surface)

   A = cross-sectional area of flow (m^2)

   R = hydraulic radius (m) = A / P, where P is the wetted perimeter

   S = slope of the energy grade line or channel be.

Questionnaire

Good day! We are 4th year Civil Engineering students from La Concepcion College conducting a research study titled “Road Design Proposal for the Pavement and Drainage System of the Road Extension from Warayan to Soldiers Hills III, Miramonte Park East.” This survey aims to gather your opinions about the current condition of the road and drainage system in your area. Your answers will help us design a road and drainage system that is safer and better for the community.

All information you provide will be kept confidential and used for academic purposes only. Thank you for your time and honest answers.

Part I. Respondent Profile

(Pakisagutan sa pamamagitan ng paglagay ng tamang sagot o pag-check ng kahon.)

1. Name(*Optional*):_____
2. Age (*Edad*):_____
3. Length of residency(*Gaano na katagal naninirahan)*:

   ☐ Less than 1 year(*Mababa sa isang taon*) ☐ 1–5 years (*Isa hanggang tatlong taon*) ☐ More than 6 years(*Higit sa anim na taon*)
4. Role (*Tungkulin*):☐ Resident (Residente) ☐ Commuter (Sumasakay) ☐ Driver (Drayber)

Part II. Road and Drainage Experience

Instruction: Please check (✓) the column that best describes your opinion.

(Pakilagyan ng tsek (✓) ang kahon na tumutugma sa iyong sagot.)

Scale:

5 – Strongly Agree (Lubos na Sumasang-ayon)

4 – Agree (Sumasang-ayon)

3 – Neutral (Walang Panig)

2 – Disagree (Hindi Sumasang-ayon)

1 – Strongly Disagree (Lubos na Hindi Sumasang-ayon)

A. Road Condition (*Kalagayan ng Kalsada*)

	5	4	3	2	1
The road in your area is uneven or has potholes. *(Ang kalsada sa inyong lugar ay may mga lubak o hindi pantay.)*					
The road becomes slippery or muddy when it rains. *(Nagiging madulas o maputik ang kalsada kapag umuulan.)*					
The road surface is rough and needs maintenance or repair. *(Magaspang na ang kalsada at kailangan ng pagkukumpuni o pag-aayos.)*					
The current road condition affects travel time. *(Nakakaapekto ang kondisyon ng kalsada sa oras ng biyahe.)*					

B. Drainage Condition (Kalagayan ng Daluyan ng Tubig)

	5	4	3	2	1
Rainwater drains easily during light or heavy rain. *(Madaling umaagos ang tubig-ulan kahit malakas ang ulan.)*					
Flooding often happens in your area during rainfall. *(Madalas bumaha sa inyong lugar kapag umuulan.)*					
Water stays on the road for a long time after the rain stops. *(Matagal matuyo o maalis ang tubig sa kalsada pagkatapos ng ulan.)*					
Clogged canals or poor drainage cause flooding in your area. *(Ang pagbabara ng kanal o hindi maayos na daluyan ng tubig ang sanhi ng pagbaha.)*					

C. Safety and Accessibility (Kaligtasan at Pag-access)

	5	4	3	2	1
Flooding causes inconvenience when going to school, work, or home. *(Nagiging sagabal ang baha sa pagpasok sa paaralan, trabaho, o pag-uwi sa bahay.*					
Flooded roads cause accidents or damage to vehicles. *(Nagiging sanhi ng aksidente o pagkasira ng sasakyan ang baha sa kalsada.)*					
The road is still passable during heavy rains. *(Madaraanan pa rin ang kalsada kahit malakas ang ulan.)*					
The road is safe for children, elderly pedestrians and vehicles. *(Ligtas gamitin ang kalsada para sa mga bata, matatanda na naglalakad at sasakyan.)*					

Thank You!